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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/668,702	09/23/2003	Keng-Chu Lin	24061.22	2195

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EXAMINER	
GEBREMARIAM, SAMUEL A	

ART UNIT	PAPER NUMBER
2811	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/668,702	LIN ET AL.	
	Examiner	Art Unit	
	SAMUEL A. GEBREMARIAM	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *23 May 2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-17,21 and 24-27* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-17,21 and 24-27* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-4, 6-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schmitt et al., US patent No., 6,913,992 in view of Tsai et al., US patent No. 6,429,115.

Regarding claim 1, Schmitt teaches (figs. 2A-2H) a semiconductor device having a first layer (110) underlying a second layer (126/124), the method comprising: forming a glue layer (114,115) directly on the first layer (110), performing an inter-treatment (col. 12, lines 53-56) on the glue layer (114,115); wherein the inter-treatment affects the upper and lower surfaces of the glue layer and improves an adhesive interface between the glue layer and the first layer (since layer 114,115 is exposed to the plasma treatment the upper and lower surface of 114,115 are affected); and wherein the inter-treatment includes applying plasma and electron beam (col. 10, lines 35-45, in addition to the plasma treatment, Schmitt teaches curing could be done using e-beam); and depositing the second layer (126/124) directly onto the upper surface of the inter-treated glue layer (114,115), wherein the inter-treated glue layer improves the adhesion

between the first (110) and the second layers (126/124), wherein the second layer is a metal layer (fig. 2H).

Schmitt does not explicitly teach that the first layer includes a metal layer.

However Tsai teaches a semiconductor device process comprising; forming a first layer (102) underlying a second layer (118) wherein the first layer (102) includes a metal layer (104) in the process of forming a multilevel interconnects with improved surface wetting ability (col. 1, lines 15-19).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the first layer including the metal layer taught by Tsai in the process of Schmitt in order to form a multilevel interconnect with improved surface wetting ability.

The limitations of "a method for increasing a time dependent dielectric breakdown lifetime of a semiconductor device" is not given patentable weight because a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Furthermore since Schmitt as modified by Tsai teach the same claimed process, the modified process is inherently capable of increasing a time dependent dielectric breakdown lifetime of the semiconductor device.

Regarding claim 2, Schmitt teaches substantially the entire claimed process of claim 1 above including performing a pre-treatment (col. 12, lines 40-45) on the first layer (110) before forming the glue layer (114,115).

Regarding claim 3, Schmitt teaches substantially the entire claimed process of claim 1 above including the inter-treatment on the glue layer (114,115) includes applying plasma to the glue layer (col. 12, lines 53-56).

Regarding claim 4, Schmitt teaches the entire claimed process of claim 1 above including selecting a reacting gas, a process time, a process temperature, a process pressure, and a reacting gas flow (refer to col. 9, lines 52-67 and col. 10, lines 1-22).

Regarding claim 6, Schmitt teaches substantially the entire claimed process of claims 1 and 4 above including the selected reacting gas is a helium-based gas (col. 9, lines 52-55).

Regarding claim 7, Schmitt teaches substantially the entire claimed process of claims 1 and 4 above the selected process time is between approximately 1 and 100 seconds (col. 10, lines 10-14), the selected process temperature is between approximately 200 and 400° C (col. 10, lines 8-10), the selected process pressure is between approximately 0.5 and 10 torr (col. 10, lines 4-7), and the selected reacting gas flow is between approximately 100 and 2500 sccm (col. 9, lines 52-55).

Regarding claim 8, Schmitt teaches substantially the entire claimed process of claim 1 above including performing the inter-treatment on the glue layer includes directing an electron beam towards the glue layer (col. 10, lines 46-53).

Regarding claim 9, Schmitt teaches substantially the entire claimed process of claims 1 and 8 above including directing the electron beam towards the glue layer further comprises defining a process power and a dosage (col. 10, lines 46-53).

Regarding claims 10 and 11, Schmitt teaches substantially the entire claimed process of claims 1 and 8 above including that the process power is between approximately 1000 eV and 8000 eV and the dosage is between approximately 50 and 500 $\mu C/cm^2$ (col. 10, lines 50-58).

3. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schmitt in view of Tsai and in further view of Lee et al., US patent No. 6,890,850.

Schmitt as modified by Tsai teaches substantially the entire claimed process of claims 1, 3 and 4 as stated above except explicitly stating the selected reacting gas is a hydrogen-based gas.

Lee teaches (col. 10, lines 1-13) applying plasma to a glue layer (114) where the reacting gas in the plasma treatment is hydrogen based (col. 9, lines 38-44).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use hydrogen base gas during plasma treatment of the glue as taught by Lee in the process of Schmitt as modified by Tsai in order form barrier layers with satisfactory polishing resistivity for damascene applications (col. 2, lines 40-44).

4. Claims 12-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., US 6,472,306 in view of Tu et al., US 5,962,344.

Regarding claims 12, Lee teaches depositing a dielectric layer (refer to col. 4, lines 9-16); depositing a first metal layer (102) on the dielectric layer; depositing a glue

layer (104) on the dielectric layer (fig. 9) and the first metal layer (102) such that an interface is formed directly between the first metal layer (102) and a lower surface of the glue layer (104) and an interface is formed directly between the dielectric layer (fig. 9) and a lower surface of the glue layer (104); forming a second metal layer (130,132) directly on the upper surface of the glue layer (104, refer to fig. 16).

Lee does not explicitly teach electing at least one of a plasma treatment process and an electron beam treatment process; applying the selected treatment process to affect the upper and lower surfaces of the glue layer; wherein the treatment process enhances adhesiveness between the dielectric layer and the second metal layer.

Tu teaches a plasma treatment process (fig. 5) where applying the selected treatment process to affect the upper and lower surfaces of the silicon nitride layer (24, col. 5, lines 30-44).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the plasma treatment process taught by Tu in the process of Lee in order minimize the problem of pinhole formation in the layer.

Since the combined process of Lee and Tu is the same as the claimed process, Lee as modified by Tu teaches the treatment process enhances adhesiveness between the dielectric layer and the second metal layer.

The limitations of “a method for increasing a time dependent dielectric breakdown lifetime of a semiconductor device” is not given patentable weight because a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably

distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Furthermore since Lee as modified by Tu teaches the same claimed process, the modified process is inherently capable of increasing a time dependent dielectric breakdown lifetime of the semiconductor device.

Regarding claim 13, Lee teaches the entire claimed process of claim 1 above including the glue layer (104) with a certain thickness.

The limitation "the selected thickness is based at least partially on a desired electrical property of the glue layer" is not given patentable weight because the feature does not add anything to the process of forming the glue layer. Furthermore since Lee is concerned with forming interconnection structure therefore Lee's process is inherently concerned with finding the desired electrical property of the glue layer.

Regarding claim 14, Lee as modified by Tu teaches substantially the entire claimed process of claim 1 above including adjusting a property of the selected treatment process based on the selected thickness of the glue layer.

Lee teaches forming the treatment over a certain depth of the glue layer. Therefore Lee as modified by Tu is inherently capable of adjusting a property of the selected treatment process based on the selected thickness of the glue layer.

Regarding claim15, Tu teaches substantially the entire claimed process of claims 1 and 14 above except explicitly stating duration of the selected treatment process.

Parameters such as process time are subject to routine experimentation and optimization to achieve the desired film quality during device fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made adjust the process time as claimed in the process of Lee in order to form a high quality glue layer.

Regarding claim 16, Lee teaches the entire claimed process of claims 1, 12 and 21 above including the glue layer is SiN (104).

Regarding claim 17, Lee teaches the entire claimed process of claims 1 and 12 above including the selected process is the plasma treatment process, and wherein a reacting gas to be used in the plasma treatment process is helium based gas (col. 7, lines 48-53).

5. Claims 21 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ting et al., US 2002/0192937 in view of Tu et al., US 5,962,344.

Regarding claim 21, Ting teaches (figs. 1-12) forming a dielectric layer (1); forming a first metal layer (2, conductive via) adjacent the dielectric layer (1); forming a glue layer (3) on the first metal layer such that a first interface is formed directly between metal of the first metal layer (2) and a lower surface of the glue layer (3) and a second interface is formed directly between the dielectric layer (1) and a lower surface

of the glue layer (3); and forming a second metal layer (12) on the upper surface of the glue layer (3) such that a third interface is formed directly between metal of the second metal layer (12) and the upper surface of the glue layer (3), and wherein the third interface overlies the first interface and second interface.

Ting does not explicitly teach performing an inter-treatment on the glue layer to alter upper and lower surfaces of the glue layer for improved adhesiveness, wherein the performing the inter-treatment includes using at least one of a plasma and an electron beam.

Tu teaches a plasma treatment process (fig. 5) and applying the selected treatment process to affect the upper and lower surfaces of the silicon nitride layer (24, col. 5, lines 30-44).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the plasma treatment process taught by Tu in the process of Ting in order minimize the problem of pinhole formation in the glue layer.

Since the combined process of Ting and Tu is the same as the claimed process, Ting as modified by Tu teaches the treatment process enhances adhesiveness between the dielectric layer and the second metal layer.

The limitations of “a method for improving an interface in a semiconductor device” is not given patentable weight because a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the

claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Furthermore since Ting as modified by Tu teaches the same claimed process, the modified process is inherently capable of improving an interface in a semiconductor device.

Regarding claim 24, Ting substantially teaches the entire claimed process of claim 21 above including the glue layer SiN (3).

Regarding claim 25, Ting teaches (figs. 1-12) forming a first metal layer (2); forming a glue layer (3) directly on the first metal layer (2), wherein the glue layer is an etch stop layer and includes silicon (layer 3 is formed of silicon nitride); and forming a second metal layer (12) directly on the upper surface of the glue layer (3).

Ting does not explicitly teach performing an inter-treatment on the glue layer to alter upper and lower surfaces of the glue layer for improved adhesiveness wherein the inter-treatment includes using plasma.

Tu teaches a plasma treatment process (fig. 5) and applying the selected treatment process to affect the upper and lower surfaces of the silicon nitride layer (24, col. 5, lines 30-44).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the plasma treatment process taught by Tu in the process of Ting in order minimize the problem of pinhole formation in the glue layer.

Since the combined process of Ting and Tu is the same as the claimed process, Ting as modified by Tu teaches the inter-treatment on the glue layer alters the upper

and lower surface of the glue layer; the second metal layer is formed directly on the altered upper surface of the glue layer and improves adhesiveness.

The limitations of "a method for improving an interface in a semiconductor device" is not given patentable weight because a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Furthermore since Ting as modified by Tu teaches the same claimed process, Tsai's process is inherently capable of improving an interface in a semiconductor device.

6. Claims 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ting in view of Tu and in further view of Cui et al., US 2004/0266123.

Regarding claim 26, Ting substantially teaches the entire claimed process of claim 25 above except explicitly stating that the inter-treatment included using the electron beam.

Cui teaches an electron beam treatment of silicon nitride film to improve the quality of the film ([0010]).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate electron beam treatment of the silicon nitride film taught Cui in the process of Ting in order to improve the quality of the film.

Regarding claim 27, Ting substantially teaches the entire claimed process of claims 25 and 26 above including the inter-treatment includes using the plasma and the electron beam process.

Response to Arguments

7. Applicant's arguments with respect to claims 21 and 24-25 have been considered but are moot in view of the new ground(s) of rejection. Applicant's arguments filed on 5/23/08 regarding claims 1-17 have been fully considered but are not persuasive. With regard to claim 1, applicant argues that layer (110) of Schmitt can not be a metal layer regardless of the combination as it would destroy the purpose of the device of Schmitt. In response, claim 1 calls for "…forming a glue layer directly on the first layer, wherein the first layer includes a metal layer…". Nothing in the claim states that the first layer has to be a metal layer; all it says is that the first layer includes a metal layer. Therefore the dielectric layer (110) can include a metal layer as shown in the rejection in order to form a multilevel interconnect.

In response to applicant's argument that Tu provides for a plasma treatment of a passivation layer and this does not disclose a glue layer with regards to claim 12, the fact that applicant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd.

Pat. App. & Inter. 1985). Applicant also points out that layer (126) is not a metal layer, that (126) is a photoresist plug. The examiner admits that this is an inadvertent error and the metal layer should read (130,132).

Conclusion

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to LYNNE A. GURLEY whose telephone number is (571)272-1670. The examiner can normally be reached on M-F 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynne A. Gurley can be reached on 571-272-1670. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Lynne A. Gurley/
Supervisory Patent Examiner, Art Unit 2811

/SAG/
September 6, 2008